

**METHOD AND APPARATUS FOR FACILITATING  
EXECUTION OF APPLICATIONS ACCEPTING LOCAL PATH  
AND URL SPECIFIED FILE PARAMETERS**

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**TECHNICAL FIELD**

The present invention relates generally to the field of software applications executed by computer processing devices. More specifically, the present invention relates to that field concerned with improving the efficiency and flexibility of such software applications.

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**BACKGROUND OF THE INVENTION**

In recent years, with the extensive use and development of the Internet and the World Wide Web, the public has benefited in many ways. Amongst the primary beneficiaries of this Internet technology are those individuals who develop and/or use computer software. In particular, given the ready accessibility of a myriad of file resources located on the Internet, data required for locally executed applications can often be copied from a remote server rather than created locally.

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Thus, for example, the extent of sharing of software development resources has increased. In particular, academic institutions and other community oriented technological groups frequently post the source code for

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commonly executed procedures and utilities on the web,  
thus saving members of the developer community time that  
would otherwise be required to write such code from  
scratch. At the time of the writing of this  
5 specification, for example, the C Interfaces and  
Implementation (CII) library at the Princeton University  
web site provides a set of Application Programming  
Interfaces (API's) useful in a wide variety of  
applications.

10 As a specific example, a hypothetical developer  
using the "C" programming language might want to use the  
CII "Atom" interface as part of the compiled source code  
for a "C" based application being developed. Fortunately  
for the developer, corresponding header and source files  
15 are located at:

[http://www.cs.princeton.edu/software/cii/pkg/include/atom](http://www.cs.princeton.edu/software/cii/pkg/include/atom.h)  
[.h](#); and

20 <http://www.cs.princeton.edu/software/cii/pkg/src/atom.c>.

Thus, the developer can access and compile such useful  
interfaces without expending extensive time and effort

writing programming code already authored by others.

Unfortunately, while enormously helpful, the use of data files stored on the Internet as parameters in locally executed applications (e.g., the compiler application noted above) is associated with certain drawbacks. In particular, in order to use stored Internet files, the files must generally first be downloaded to a local storage medium. Such downloading generally requires a separate step manually initiated by the developer or other software user.

For example, returning to the example described above, since compilers typically do not accept URL specified files as parameters, in order to compile the source and header files atom.c and atom.h, the developer must first copy the files to a local directory (e.g., via an FTP protocol utility). Only when the source and header files have been downloaded can the developer compile the shared source code (e.g., by causing execution of a compile command such as "cl /FeMyApp.exe main.c atom.c"). Furthermore, to ensure the latest version of the CII Atom interface is used, the developer must complete such a download each time the interface is needed for a given compilation, resulting in significant

inconvenience.

Thus, what is needed is a way for compilers and other locally executed software applications using data files stored on the Internet to access such files automatically and without creating extra work for the developers and users.

### SUMMARY OF THE INVENTION

The present invention satisfies this need. In particular, the present invention incorporates within the software application, input/output functionality successfully accepting both local directory path specified, and Uniform Resource Locator ("URL") specified, file parameters. Specifically, in accordance with the present invention, the software includes a procedure whereby a file name is first determined to either constitute or not constitute a URL. If the name is determined not to constitute a URL, conventionally known Input/Output procedures for locally stored files are executed. Such procedures are of the type commonly included in Application Programming Interfaces ("API's") applicable to various programming languages and platforms. Otherwise, if the identifier is determined to be a URL, a different set of Input/Output procedures,

designed to process data streams stored on the World Wide Web, are executed.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 is a block diagram representing a computer system in which aspects of the present invention may be incorporated.

Figure 2 is a high level view of a network environment in which an embodiment of the present invention may be implemented.

Figure 3A is a high level flow chart depicting the conventional execution of a software application performing I/O operations on a locally stored file.

Figure 3B is a high level flow chart depicting the execution of a software application successfully performing I/O operations on either a locally stored file, or URL specified remote file, in accordance with an embodiment of the present invention.

Figure 4 depicts a standard URL structure that may be used to determine whether a file name is, or is not, a remote file stored on the World Wide Web in accordance with an aspect of the invention.

Figure 5A is a high level flow chart depicting a well known two-step process for executing a software

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application using remotely stored data.

Figure 5B is a high level flow chart depicting a one step process for executing a software application using remotely stored data in accordance with an embodiment of the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

### OVERVIEW

The present invention allows applications to successfully accept local path specified, as well as URL specified, I/O file parameters. Thus, during execution it appears to the application user (e.g., the developer in the case of a compiler application) as if both local and web-based files are stored on the local storage medium.

Although this invention is described with respect to specific computing implementations, the scope of the present invention is by no means limited to those contexts.

### EXEMPLARY OPERATING ENVIRONMENT

Figure 1 and the following discussion are intended to provide a brief general description of a suitable computing environment in which the invention may

be implemented. The invention will be described in the general context of computer-executable instructions, such as program modules, being executed by a computer, such as a PC client workstation capable of issuing requests to a web server. However, those skilled in the art will appreciate that the invention may be practiced with other computer system configurations, including hand held devices, multi-processor systems, microprocessor-based or programmable consumer electronics, network PCs, minicomputers, mainframe computers and the like.

With reference to Figure 1, an exemplary system for implementing the invention includes a general purpose computing device in the form of a conventional personal computer 20 or the like, including a processing unit 21, a system memory 22, and a system bus 23 that couples various system components including the system memory to the processing unit 21. The system bus 23 may be any of several types of bus structures including a memory bus or memory controller, a peripheral bus, and a local bus using any of a variety of bus architectures. The system memory includes read only memory (ROM) 24 and random access memory (RAM) 25. A basic input/output system 26 (BIOS), containing the basic routines that help to

transfer information between elements within the personal computer 20, such as during start-up, is stored in ROM

24. The personal computer 20 may further include a hard disk drive 27 for reading from and writing to a hard

5 disk, not shown, a magnetic disk drive 28 for reading from or writing to a removable magnetic disk 29, and an

optical disk drive 30 for reading from or writing to a removable optical disk 31 such as a CD ROM or other

optical media. The hard disk drive 27, magnetic disk

10 drive 28, and optical disk drive 30 are connected to the system bus 23 by a hard disk drive interface 32, a

magnetic disk drive interface 33, and an optical drive interface 34, respectively. The drives and their

15 associated computer readable media provide non-volatile storage of computer readable instructions, data

structures, program modules and other data for the

personal computer 20. Although the exemplary environment described herein employs a hard disk, a removable

magnetic disk 29 and a removable optical disk 31, it

20 should be appreciated by those skilled in the art that

other types of computer readable media which can store

data that is accessible by a computer, such as magnetic cassettes, flash memory cards, digital video disks,

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Bernoulli cartridges, random access memories (RAMs),  
read-only memories (ROMs) and the like may also be used  
in the exemplary operating environment. Further, as used  
herein, the term "computer readable medium" includes one  
5 or more instances of a media type (e.g., one or more  
floppy disks, one or more CD-ROMs, etc.).

Generally, program modules include routines,  
programs, objects, components, data structures and the  
like that perform particular tasks or implement  
10 particular abstract data types. A number of such program  
modules may be stored on the hard disk, magnetic disk 29,  
optical disk 31, ROM 24 or RAM 25, including an operating  
system 35, one or more application programs 36, other  
program modules 37 and program data 38. A user may enter  
15 commands and information into the personal computer 20  
through input devices such as a keyboard 40 and pointing  
device 42. A monitor 47 or other type of display device  
is also connected to the system bus 23 via an interface,  
such as a video adapter 48. In addition to the monitor  
20 47, personal computers typically include other peripheral  
output devices (not shown), such as speakers and  
printers.

A personal computer 20 may operate in a

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networked environment using logical connections to one or more remote computers, such as a remote computer 49. The remote computer 49 may be another personal computer, a server, a router, a network PC, a peer device, a web server or other common network node, and typically includes many or all of the elements described above relative to the personal computer 20, although only a storage device 50 has been illustrated in Figure 1. The logical connections depicted in Figure 1 include a local area network (LAN) 51 and a wide area network (WAN) 52. When used in a WAN networking environment, the personal computer 20 typically includes a modem 54 or other means for establishing communications over the wide area network 52, such as the Internet. The modem 54, which may be internal or external, is connected to the system bus 23 via the serial port interface 46. It will be appreciated that the network connections shown are exemplary and other means of establishing a communications link between the computers may be used.

Where the WAN environment is the Internet (which can also be viewed a number of WANs), various protocols may be used to exchange commands and data between computers connected in the WAN. The protocols

include the File Transfer Protocol (FTP), the Hyper Text Transfer Protocol (HTTP) and the Gopher document protocol. Generally, files stored on the web can be downloaded from a web server 49 using the FTP

functionality of an FTP software module executing on the client workstation 20 processor 21. Figure 3 shows a high level view of a network environment in which an embodiment of the present invention may be implemented.

EXEMPLARY SOFTWARE EXECUTION ACCEPTING URL SPECIFIED OR  
LOCAL PATH SPECIFIED FILE PARAMETERS

Turning now to Figures 3A and 3B, they are high level flow charts that show the processing of a received file name parameter during application execution in accordance with prior art, and in accordance with an embodiment of the present invention, respectively. For example, Figure 3A depicts a conventionally known application execution.

In Step 300, an application 36 commences execution on a client computer 20 processor 21. During execution, the application 36 processes and manipulates input in the form of file data 38. The application 36 typically identifies and locates the file 38 by accepting a file name parameter that either explicitly or implicitly

includes a local directory path indicating where the file data 38 is stored. File name and location conventions are typically determined by the Operating System 35, such as for example a Windows 2000® operating system, running on the client 20.

Having accepted the file name parameter, in Step 310, the application 36 can commence processing the file data 38. Initially however, the file 38 identified must be processed to perform low level I/O processing. Such I/O processing is typically coded in procedures contained in the API's provided for particular computing environment platforms or in the I/O libraries used in various object oriented programming language implementations (e.g., C, C++, Java etc.) The procedures are thus typically accessible to developers and constitute building blocks of the program code corresponding to the software application 36 executed in Step 300. Appendix A includes conventionally known source code for such procedures. These procedures conventionally include: (1) an "Open" procedure for accessing a file and opening a data stream; (2) a "Read" procedure for reading the data stream; (3) a "Write" procedure for writing a data stream; and (4) a "Close"

procedure for closing an open data stream.

For example, if the application 36 is a compiler application as in the example described above, low level "Open" and "Read" procedures accepting the file name parameter and perform low level I/O processing on the local file 38 identified. Once the stream of file data 38 is opened-i.e., in this example a stream of source code-compilation processing of the file data 38 is executed and completed.

By contrast, the execution of an application coded in accordance with an embodiment of the present invention is shown in Figure 3B. Again, in Step 320, an application 36 commences execution on a client computer 20 processor 21. However, upon accepting a file identifier parameter, in Step 330, the application 36 first determines whether or not the file name parameter is or is not a URL.

The determination of whether the file name parameter is nor is not a URL is made possible because URL's are structured according to particular syntax. In particular, the conventionally known W3C standard specifies what constitutes a valid URL and explains its semantics.

For example, Figure 4 is a high level view of the

overall structure of a URL in accordance with that standard. Generally, as depicted in Figure 4, a URL consists of four components: a Scheme component, an Authority component, a Path component and a Query component. These components are illustrated in Figure 4 using the following URL as an example:

http://www.cs.princeton.edu/software/cii/pkg/src/atom.c

The scheme component identifies the scheme used to access a remotely stored file specified by the URL. For instance, the "http://" portion of the above URL indicates that http protocols must be used to access the file.

The authority component typically specifies an Internet-based server 49 that constitutes the naming authority providing a reference that gives meaning to the location path specified in the remainder of the URL. For example, the "www.cs.princeton.edu" portion of the above URL indicates a particular server 49 having a particular IP address as a naming authority.

The Path component contains location data, specific to the naming authority (i.e., the server 49), locating the URL specified file. For example, the "/software/cii/pkg/src/atom.c" portion of the above URL

specifies the path on the server 49 of the "atom.c"  
source code 38 identified by the above URL.

Finally, the query component is a string of  
characters providing parameters that can be passed with  
and executed by the URL specified file assuming the file  
is in executable form (e.g., an ASP or CGI script file).  
In the currently considered URL, there is no query  
component (although the application of the presently  
described embodiment includes functionality checking for  
a query component).

Returning to Step 330 of Figure 3B, the  
application determines whether the passed file name  
parameter is a URL checking for Scheme, Authority, Path  
and Query components and other URL specific  
characteristics.

If it is determined that the passed file  
identifier parameter is not a URL, then, in Step 340,  
processing continues as in Figure 3A. That is,  
continuing with the compiler example, the file 38  
identified is processed with the standard "Open" and  
"Read" I/O available for locally stored files, and is  
subsequently compiled.

However, if it is determined that the passed file

identifier parameter is a URL, then, in Step 350, the  
file 38 identified by the URL is processed with revised  
"Open" and "Read" I/O procedures customized to data files  
stored on the web. Sample source code for such revised  
5 net I/O procedures are set forth in Appendix B. In a  
preferred embodiment of the present invention, the net  
I/O functions are contained in Win 32 platform API  
procedures for accessing the Internet. (Win32 API  
procedures require a Windows® operating system platform).  
10 Thus, during program 36 execution a stream of file data  
38-i.e., in this example a stream of "atom.c" source  
code-is opened and read over web links 82 using web  
protocols. Once downloaded or partially downloaded,  
compilation of the source code file data 38 can commence.

15 Thus, since the compiler application 36 has  
integrated net I/O functionality, no download of the  
"atom.c" source code is required prior to execution.

Note that with respect to Figure 3B above, while an  
embodiment of the present invention is described with  
20 respect to a compiler application, the present invention  
is in no way limited compilers. For example, the  
application may be a word processing application that,  
during execution, accepts a file parameter identifying an

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existing word processing document file stored on a web  
server 49. The document can thus be opened and edited.  
The application may be financial tracking and calculating  
software that accepts an identifier specifying a remotely  
5 stored file of financial data that can then be updated  
with recently completed financial transactions.

Further, because of the applicability of the present  
invention to a wide variety of applications, in a  
preferred embodiment of the present invention, the  
10 functionality described, particularly with respect to  
steps 330 and 350 of Figure 3B, is incorporated in  
software or API's ensuring wide availability of the  
features of the present invention to many software  
developers. For example, this functionality can be  
15 provided either as part of I/O libraries included with  
programming language implementations or in existing  
operating system 35 API's. (Currently, Operating systems  
provide separate API's for accessing the Internet, rather  
than including such functionality in standard file I/O  
20 procedures). Where the functionality is embedded in  
operating systems 35 or operating system 35 tools, every  
user of that platform could potentially benefit.

Having described the I/O functionality of an

application 36 in accordance with aspects of the present invention, the benefits of the present invention are now illustrated with reference to Figures 5A and 5b. Figure 5A, it shows the execution of a standard application using a file input in accordance with the prior art. In Step 500, the file being passed (e.g., the "atom.c" source code) to the application 36 is downloaded to the client 20 system. In Step 510, the application 36 is executed using the downloaded file data 38 as input. For example, in the MS Visual C (Microsoft Corporation) program development environment, the specification and line entry of the command "cl /FeMyApp.exe main.c atom.c" causes compilation of the source code data corresponding to the "atom.c" file name.

Thus the prior art compilation requires a two-step process on the user's part. If, by contrast, the source code had not been downloaded, the compilation would not complete successfully. That is, if the file name parameter passed to an application is a URL, the application would generally be unable to find the URL specified file and would prematurely terminate the compilation returning an error.

By contrast, Figure 5B depicts an application 36

execution wherein the application 36 incorporates net I/O functionality in accordance with an embodiment of the present invention. The execution is a one step process wherein the developer merely specifies a command such as

5 "cl /FeMyApp.exe main.c

<http://www.cs.princeton.edu/software/cii/pkg/src/atom.c>"

Prior download of the "atom.c" source code is not required for successful compilation.

Thus, the present invention provides benefits  
10 program developers as well as any software user. While the invention has been described above in detail and with reference to specific embodiments thereof, it will be apparent to one skilled in the art that various changes and modifications can be made therein without departing  
15 from the spirit and scope thereof. Therefore, the scope of the invention should be understood with reference to the following claims.